

Using the Xact™ Multi-Metals CEMS as a Mercury Monitor on a Coal-Fired Power Plant: A Feasibility Study



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Executive Summary

- **Review of Xact™ Design and Operation**
- **Goals of Feasibility Study**
- **Results of Laboratory Phase of Study**
- **Field Deployment and Performance Test Results**

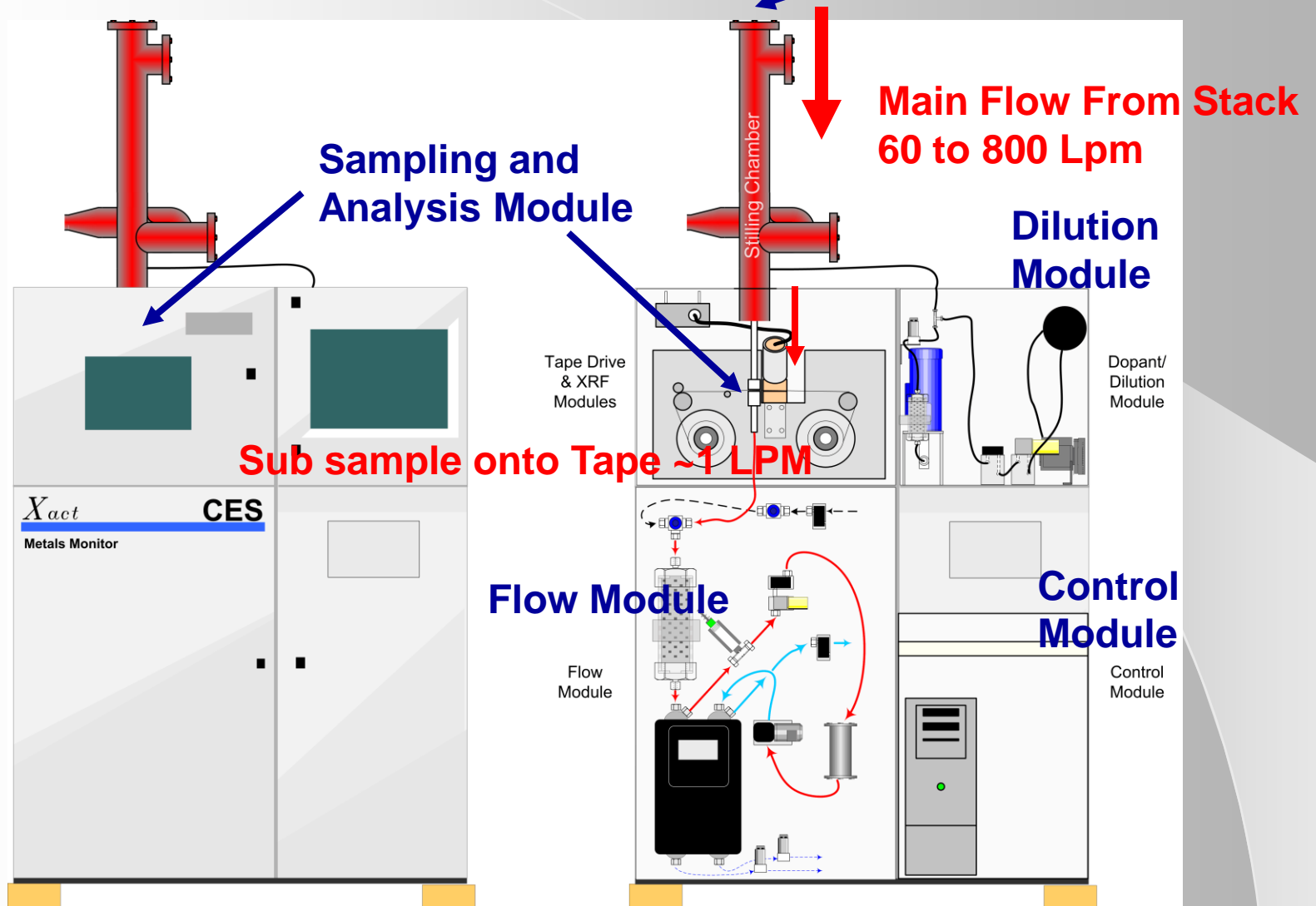
The Xact™ Multi-Metal CEMS



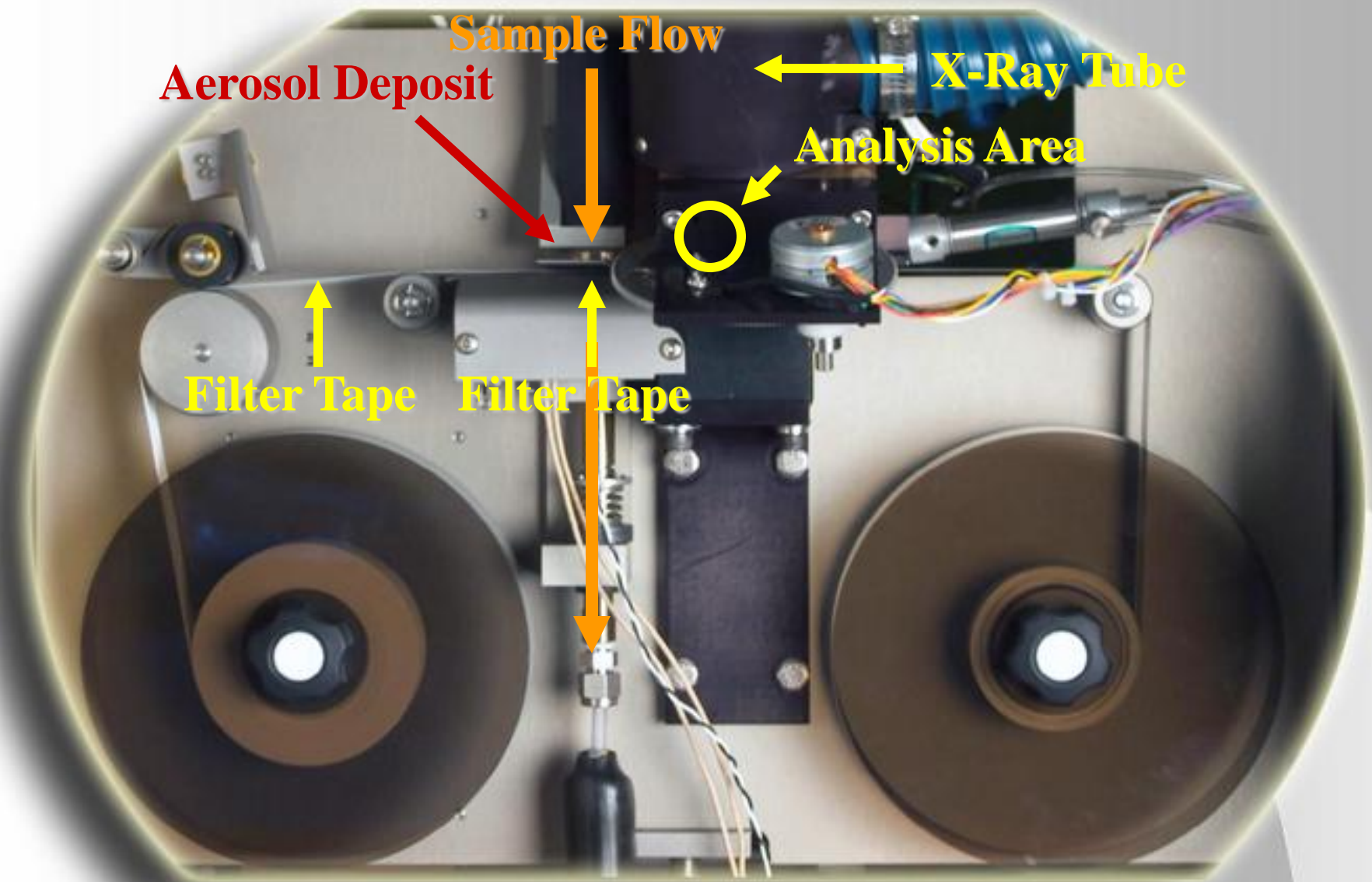
- Developed by Cooper Environmental Services (CES)
- Developed as a Multi-Metals CEMS
- Based on X-ray Fluorescence Analysis (XRF)
- Beta –gauge type reel-to-reel tape drive and sampling technology
- Can measure up to 20 metals simultaneously including Cr, As, Cd, Hg, and Pb

Xact™-CEMS

Connect to Probe and
Transport Line



XACT™ SAMPLING AND ANALYSIS



Determination of Stack Concentration

$$\text{CONC } (\mu\text{g}/\text{m}^3) = \frac{\text{Mass (XRF)}}{\text{VOLUME (MFM)}}$$

Xact™ CEMS

**EPA Method 301
Validated for
Multi-Metals**

**EPA Site
Certified**



**AMP EPA
Approved**

**~6 Years On-
Stack Operations
on Hazardous
Waste Incinerator**

**May 2007 – EPA Clean Air
Excellence Award**

Key Goals of Feasibility Study

- **Demonstrate Xact Operation on a Coal Fired Power Plant**
- **Can the Xact Meet the Mercury Monitoring (PS-12A) Requirements for Initial Certification Specified by the Clean Air Mercury Rule (CAMR)?**


PS-12A Initial Certification

Requirements (2007) **Current PS 12A**

Requirements Are In Red

Test	Required Frequency	Required Standards	Passing Criteria
7- Day Calibration Check	1 x per day for seven days	<ul style="list-style-type: none"> Zero Upscale 	5% of Hg Span Value -OR- Less than 1 $\mu\text{g}/\text{m}^3$ difference
Linearity Check	Once	Hg ⁰ Standard at Low, Mid and High Span Values	10% of reference value 5% -OR- Span Value Less than 1 $\mu\text{g}/\text{m}^3$ difference
3-Level System Integrity Check	Once	HgCl ₂ Standard Low, Mid, High Span Values	5% of Span Value 10% of Span Value
Relative Accuracy Test (RATA)	Once	<ul style="list-style-type: none"> Ontario Hydro Method 30B (Sorbent Trap) 	20% of Reference Method -OR- Less than 1 $\mu\text{g}/\text{m}^3$ difference

Measurement Error



HgCl₂ and Hg⁰ Generator

- Xact™ did not have a HgCl₂ or Hg⁰ Generator
- Used Commercially Available HovaCal™
- HovaCal™ operates by evaporating a solution of HgCl₂ on a heated surface
- HgCl₂ Solution of known concentration was metered at a measured flow rate into a measured air flow
- Hg⁰ is generated by chemically converting the HgCl₂ to elemental Hg (Hova Merc)

Initial Laboratory Tests – Xact™ Calibration

- XRF Portion of the Xact Calibrated Using Thin Film Standards
- These standards are typically used for calibration of XRF equipment for the analysis of Ambient Air Filters (EPA IO 3.3)
- Flow Portion Meter
- Calibration for Quantitative
- QAG Audit Approved Alternative Monitoring Petition

Xact Mercury Calibration is Completely Independent of the HgCl_2 and Hg^0 Generator Used to Check It.



Reference Flow

ing

Approved

Initial Laboratory Tests With HovaCal™ HgCl₂ Linearity

Concentration Level	Nominal Concentration (mg/m ³)	# of Samples	Average Percent Difference (% of Span)	Pass Test Criteria?
Zero (DI Water)	0	6	0.40%	Yes
Low	2	8	-2.37%	Yes
Low Mid	4	6	-0.69%	Yes
High Mid	11	6	-4.10%	Yes
High	18	8	-4.17%	Yes

Also Passed Current 12A Criteria

Initial Laboratory Tests with HovaCal™ Elemental Hg Linearity

Concentration Level	Nominal Concentration (mg/m³)	# of Samples	Average Percent Difference (% of Reference)	Pass Test Criteria?
Low	4	7	2.66%	Yes
Mid	11	6	8.69%	Yes
High	18	8	0.45%	Yes

Xact™ Met All Tested PS-12A Criteria During Laboratory Evaluation

With New PS12A Criteria

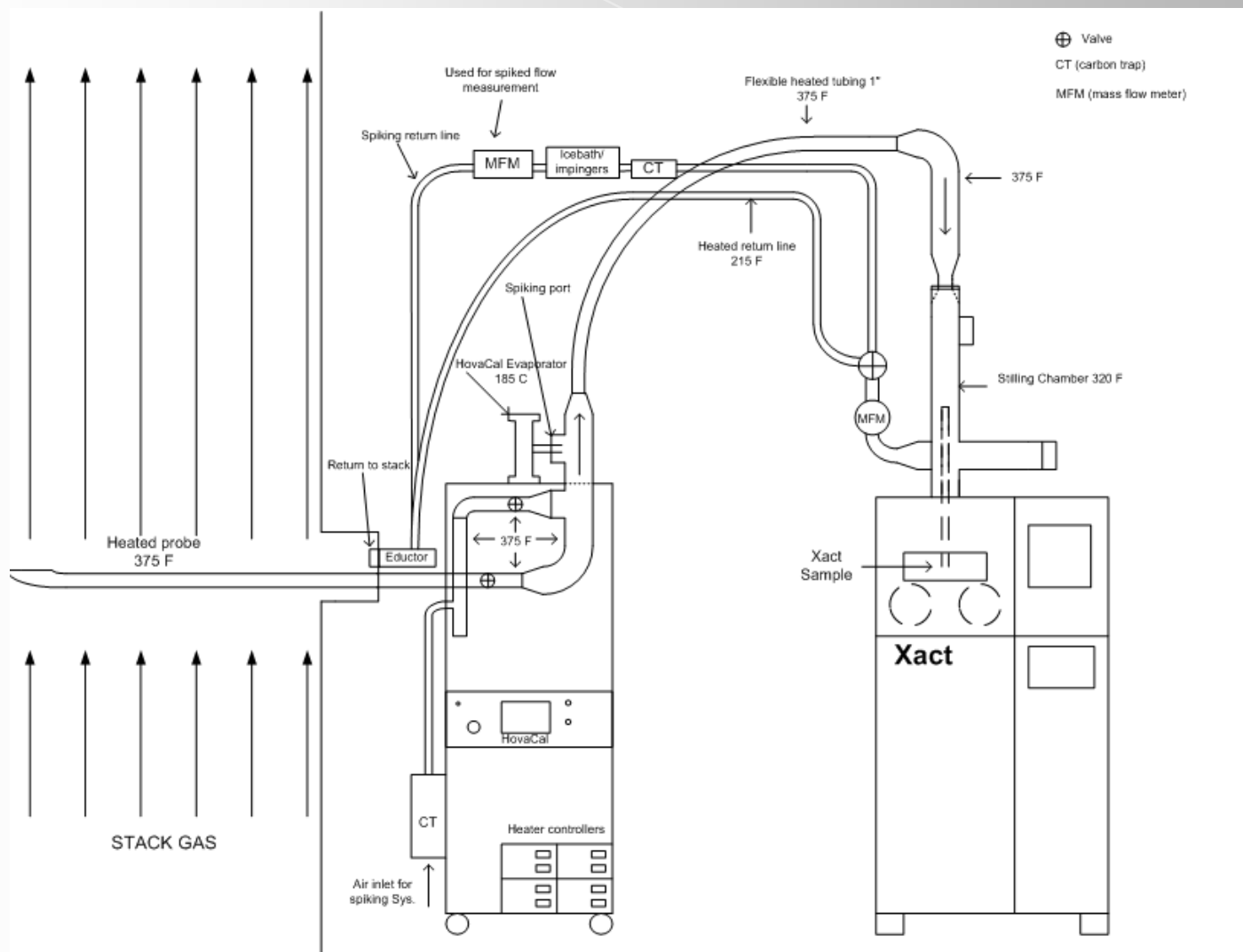
Concentration Level	Nominal Concentration (mg/m³)	# of Samples	Average Percent Difference (% of Span)	Pass Test Criteria?
Low	4	7	0.57%	Yes
Mid	11	6	4.46%	Yes
High	18	8	0.45%	Yes

Field Deployment

- Xact™ installed at PGE's Boardman Facility
- 585 MW Facility, ESP Controls
- Lab XRF Calibration Used – Not Recalibrated in Field
- Installed and operating within 2 days
- Side by side comparison with Thermo Mercury Freedom Unit
- Two week field deployment
- Performed initial performance specification including:
 - 7 Day Calibration Check
 - Linearity Check
 - System Integrity Check
 - RATA – Method 30B



Field Test Arrangement

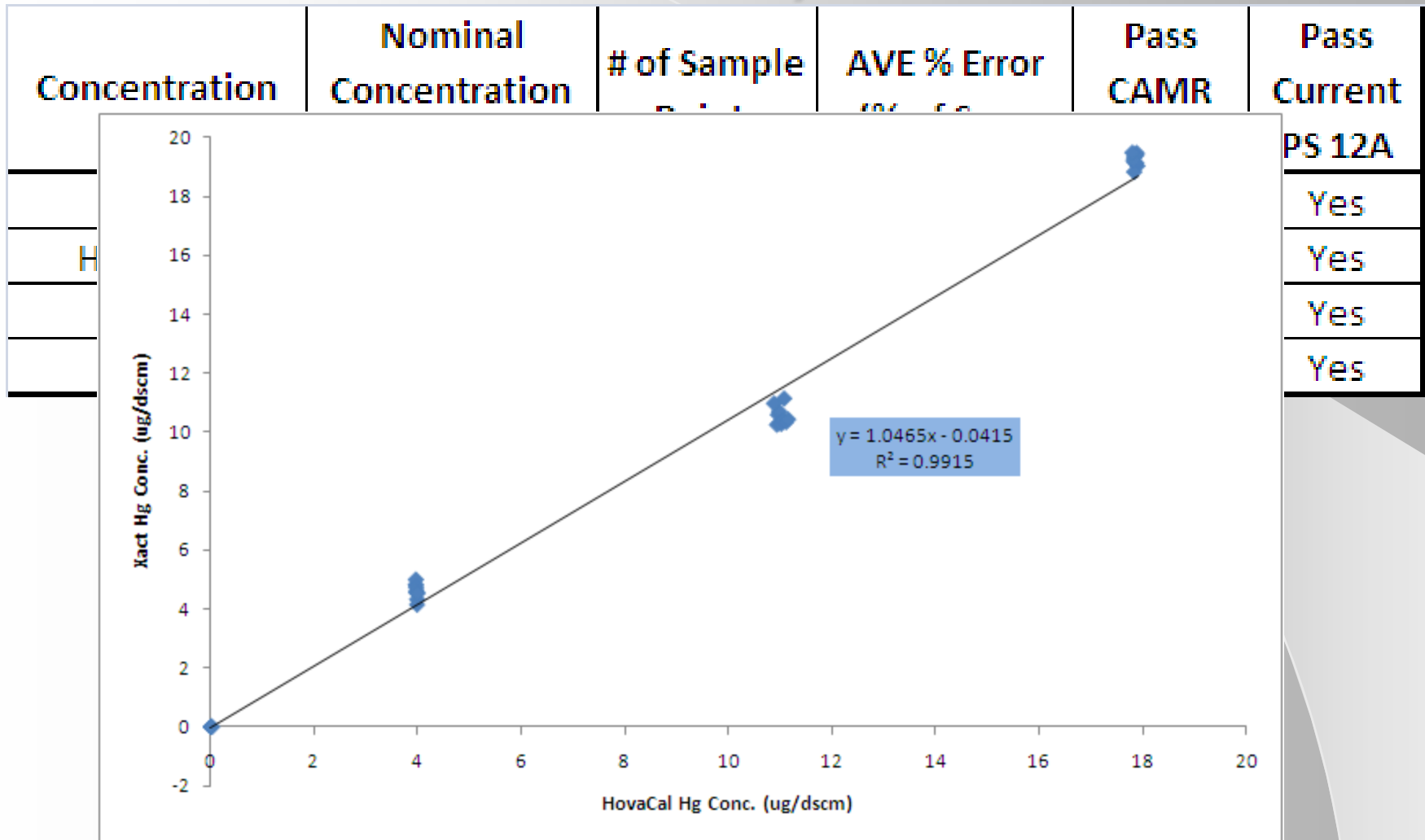


Seven Day Drift Test Results

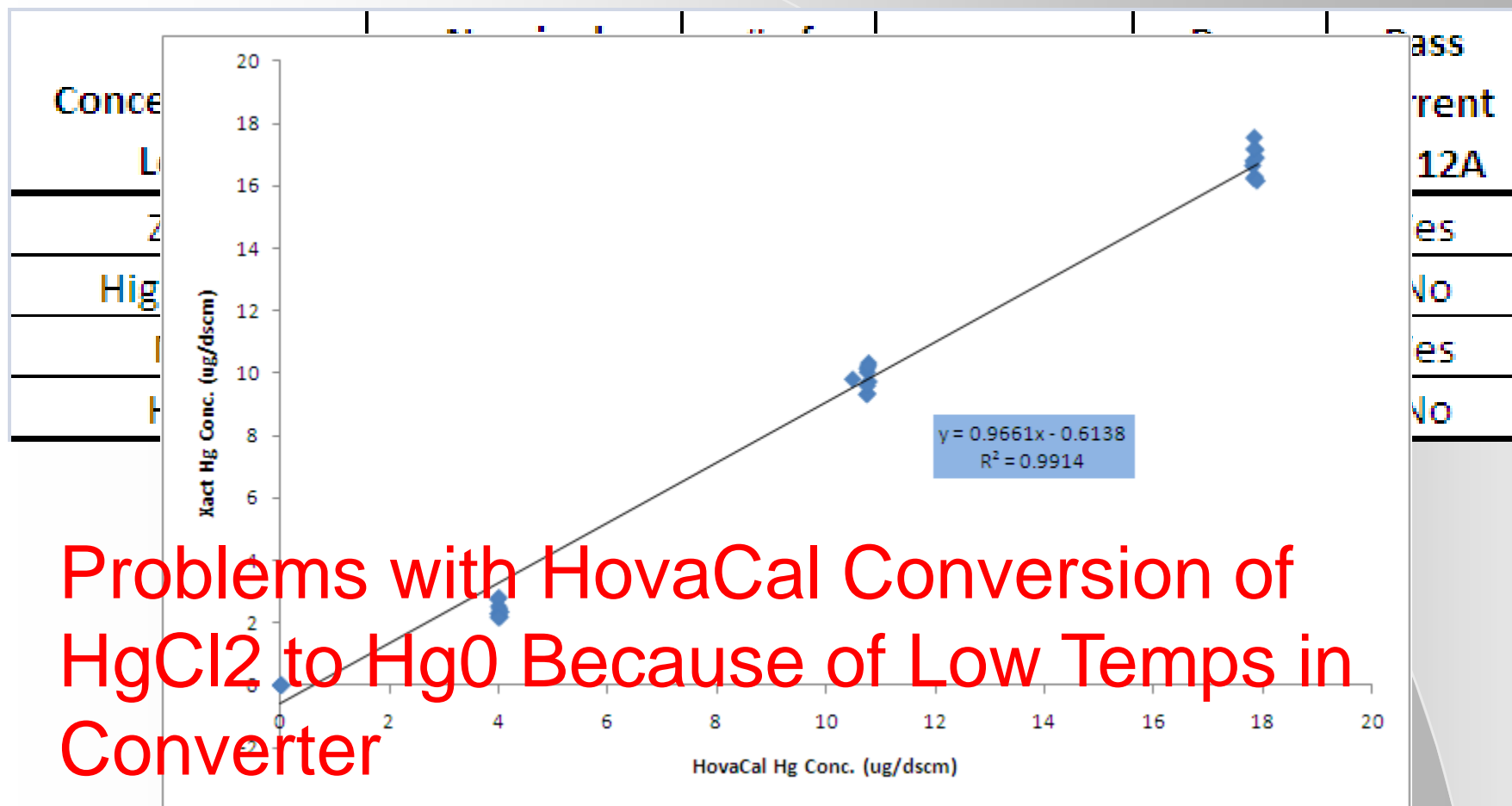
Date	Zero Drift Results			Upscale Drift Results		
	Ave Difference (% of Span)	CAMR Rule Met on Average	Number of Points CAMR Rule Met	Ave Difference (% of Span)	CAMR Rule Met on Average	Number of Points CAMR Rule Met
3/23/2009	0.00	Yes	9	11.34	No	0
3/24/2009	0.00	Yes	9	6.71	No	1
3/25/2009 ^a	0.00	Yes	9	-6.06	No	3
3/26/2009	0.00	Yes	9	11.47	No	0
3/27/2009	0.00	Yes	9	2.80	Yes	8
3/28/2009	0.33	Yes	9	2.14	Yes	8
3/29/2009	2.37	Yes	9	-2.60	Yes	9

- Zero Drift Met on all Days – indicating little loss of Hg
- Difficulty Meeting Upscale – Problems with HovaCal™

Field HgCl_2 Linearity (System Integrity Check)



Field Hg⁰ Linearity



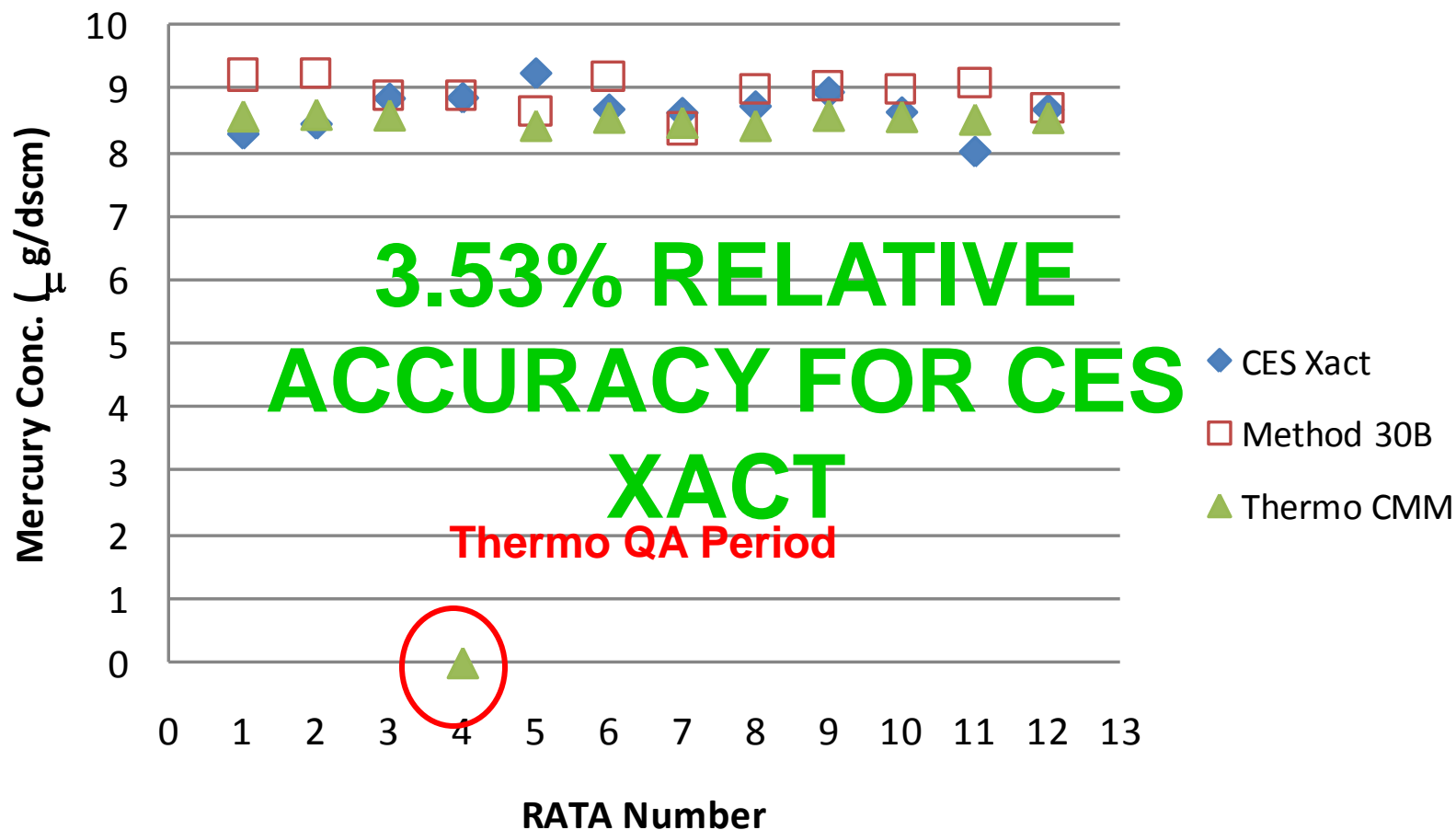
Why we think there was a problem with HovaCal™

- Visible Rust in Tubing Exiting HovaCal™
- Problems Maintaining Heating – heater would frequently fail requiring the HovaCal™ to cool down and restart
- Were Using HovaCal™ at the Very High End of Recommended Emission Range

Thermo Hg Freedom Comparison

Date(s)	Xact	Thermo	Ave % Difference
3/20/2009	8.91	8.49	4.87
3/21/2009	7.12	8.25	-13.52
3/22/2009	6.94	7.96	-12.54
3/23/2009	7.16	7.76	-7.13
3/24/2009	7.28	7.39	-1.53
3/25/2009	7.97	7.14	11.63
3/26/2009	7.55	7.30	3.44
3/27/2009	6.88	6.65	4.00
3/28/2009	6.83	6.54	4.91
3/29/2009	6.90	7.65	-10.67
3/30/2009	7.83	8.89	-12.07
3/31/2009	8.36	8.58	-2.46
All Days	7.42	7.78	-4.09

RATA Results



Conclusions

- **CES Xact Can Accurately Measure Mercury in a Coal Fired Power Plant**
- **If the Xact™ had recalibrated to the mercury generator (HovaCal™) as most Hg CEMS do – it would likely have failed the RATA**
- **It is feasible to use the Xact to Measure Mercury on a Coal Fired Power Plant**
 - **Need a Mercury Generator Designed to Operate on Xact™ Flows**

Differences Between Xact™ and AF Based Mercury Monitors

- Xact™ Requires Longer Sampling Times (15 minutes versus 1 to 2 minutes)
- XRF Calibrations are very stable (1 year or more) AF needs to be recalibrated frequently
- Xact™ is less dependant on the accuracy of the Hg generator
- Since XRF is Non Destructive Samples Can be Archived and Potentially Reanalyzed if Data needs to be validated
- Xact™ could be used to monitor for other metals
 - PM is a surrogate for HAP Metals
 - If EPA requires PM CEMS on CFPP Xact could potentially be used for Hg and HAP metals
 - Therefore 1 CEMS (multi-metals including Hg) instead of 2 Hg CEMS and PM CEMS

QUESTIONS?

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